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ABSTRACT

On May 10, 1950, President Truman signed the bill creating the National Science Foundation (NSF). The act provided for a National Science Board to be created and the law directed the agency to encourage and develop a national policy for the promotion of basic research and education in the mathematical, physical, medical, biological, engineering, and other sciences; to initiate and support basic scientific research in the sciences; and to evaluate the scientific research programs undertaken by agencies of the federal government. The chapters in this history of the NSF include: (1) "The Past is Prologue"; (2) "The Early Years to Sputnik"; (3) "From Sputnik through the Golden Age, 1957-1968"; (4) "Tumultuous Times, 1968-1976"; and (5) "New Concerns; New Opportunities, 1977-1985." A concluding bibliographical note contains 22 specific references. (PR)

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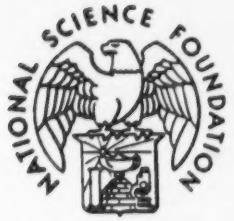

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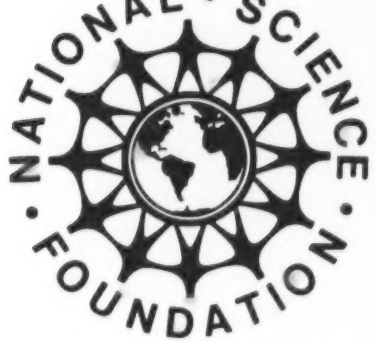

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A BRIEF HISTORY

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THE NATIONAL SCIENCE FOUNDATION:

A BRIEF HISTORY

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PREFACE

The past is dead; long live the past! History provides a unique and valuable perspective. An account of things past allows one to see broad themes that recur in the present and and continue into the future. History does not repeat itself exactly, but events and issues of the past do have a tendency to reappear albeit in slightly different form. That is why the aphorisms, "Study the Past" and "What is Past is Prologue," carved into the entrance to the National Archives, are cited so often. Policy makers run the risk of "reinventing the wheel" when they make judgments on problems they face unless they are well informed about the context in which previous decisions of a similar nature were made, what alternatives were considered, why certain ones were chosen, and what personal and impersonal forces shaped a particular policy. Thus history can be a useful component of sound public policy.

This brief survey of the Foundation makes no claim at being a definitive account. More research into the many activities of the agency is needed before an overall judgment can be reached. Nonetheless, the ensuing story may be helpful to agency personnel and members of the public needing to know something about the major issues and events that confronted the agency throughout its history. It should be read, however, with the understanding that it is only a preliminary assessment.

Several Foundation "old hands," as well as others who are relatively new to the agency, read drafts of the paper. I appreciate the time and effort they put in on the task. I considered their comments with great care and, where I felt appropriate, have incorporated them herein. I alone, however, accept responsibility for all statements of fact and interpretations.

George T. Mazuzan
NSF Historian

CHAPTER I

THE PAST IS PROLOGUE

A consensus among historians is that the Second World War has been the watershed event in 20th century American history at least, and perhaps in world history. Never could there be a return to the earlier days of the century. The war thrust the still historically young United States into the lead as the world's premier power. America emerged from the conflict untouched by the physical destruction that laid waste so many of both its rivals and allies. Its capital infrastructure likewise was intact. At war's end the United States dominated as no nation had done since Great Britain controlled its vast empire in the 19th century. The immediate postwar years nonetheless proved to be a time when the nation would be taxed to provide leadership and policies for not only rebuilding a war-torn world but also returning to a domestic situation that would bring some semblance of normalcy from the crises of the preceding fifteen years.

World War II and the prewar Great Depression--an historic combination of two important epochs--caused a vast expansion of government agencies and services at the federal level. The back-to-back crises of the 1930s and 1940s also caused a majority of Americans to look to the national government to perform a myriad of functions, from providing employment to insuring bank deposits to mobilizing industry and universities for the war effort. Since 1789 the federal government had slowly taken a more active role in the affairs of the nation. Events after 1929, and particularly after the inauguration of Franklin D. Roosevelt as president in 1933, accelerated government activism. By early in the Second World War many political leaders, as well as citizens brought into the government to help with the crisis, recognized that in many areas continued government activity after the war would be in the best interest of the nation.

Support of basic scientific research was an area affected by increased government involvement. There had been numerous, if modest, government-science interactions throughout the history of the Republic, but the Second World War vastly intensified that environment. Not only was government support of scientific endeavors sharply escalated, but the relationships among government agencies, universities, private foundations, and industry were altered in ways that disallowed a return to prewar times. The war greatly strengthened, for example, the link between the nation's universities and the government. Even more far-reaching was the role of the military as a large and permanent supporter of basic and applied scientific research. As

early in the war as 1942, these accelerating government-science community relationships interested some politicians about whether research support would be continued after the war.

The situation prompted a New Deal senator from West Virginia, Harley Kilgore, to introduce in 1942, 1943, and 1945 successive pieces of legislation aimed ultimately at creating a National Science Foundation. Reflecting his populist New Dealer views, Kilgore envisioned a broad science organization (including the social sciences) that supported through grants and contracts both basic and applied research and incorporated geographic distribution of research funds. The agency would be responsible to political authority. The year-to-year Kilgore hearings and legislation quite naturally interested the scientific community, which had a major stake in the outcome.

One leading science spokesman was Vannevar Bush, a respected engineer and science administrator who headed the government's wartime Office of Scientific Research and Development. Bush agreed with Kilgore that federal support of science should continue after the war, but he disagreed with the senator's approach. Partially to counter it Bush maneuvered to have President Roosevelt request from him a report on how the nation should support science in the postwar period. Bush's 1945 response, Science--The Endless Frontier, became famous as the prescription for government support of science. It also was an antidote to the Kilgore suggestions.

Science--The Endless Frontier argued strongly for the concept of continued government support of science, but it proposed carrying out the function in the traditional manner in which Bush was most experienced. The report defined the method: through a government agency that supported only the best "basic research in the colleges, universities, and research institutes, both in medicine and the natural sciences, adapted to supporting research on new weapons for both Services, [and] adapted to administering a program of science scholarships and fellowships." Best science in Bush's mind had to be elitist in the sense of supporting the most excellent scientists; it had no formula for geographic distribution. Bush nonetheless saw support of science as promoting the general welfare and not just a few scientists. From his short catchy title onward, Bush capitalized on a popular American historical theme: "... the frontier of science remains. It is in keeping with the American tradition--one which has made the United States great--that new frontiers shall be made accessible for development by all American citizens." He argued that government support of science research and education would benefit everyone through its contributions to the peacetime economy and national security. The same day the White House released the report, Bush had arranged with Democratic Senator Warren Magnuson of Washington to introduce a bill that incorporated the ideas contained in Science--The Endless

Frontier.

Five years passed before Congress and the administration found common political grounds on which to create a National Science Foundation. It took that long, and a presidential veto, to work out the many compromises necessary to bring reality from the differences in the Kilgore and Magnuson versions of the idea. Debate revolved around several issues: patent ownership, geographical distribution of funds, inclusion of the social sciences, basic versus applied research, and administrative control of the agency. Nebulous interpretive language eventually bridged the differences. The new agency, for example, was to avoid "undue concentration" of its funds, thus leaving the geographic distribution question to interpretation by the leaders of the Foundation. The thorny question of the social sciences was not resolved; the act's term, "other sciences," could be read to include the social sciences entrance but gave them second-rate status compared to the mathematical, physical, biological, medical, and engineering sciences that were specifically mentioned in the statute.

Administrative control of the agency brought the biggest imbroglio. Bush and his supporters wanted authority placed in a part-time independent board dominated by scientists that would appoint a director who would be responsible to the board. Any other arrangement Bush feared might bring political control of the agency's support of research. Thus he took the elitist position; he thought the best research should be directed independently by those who knew science best--the scientists themselves. After two years of debate, in 1947, Congress passed a measure along the lines Bush advocated, but it was unacceptable to President Harry S Truman. His veto message noted that the act allowed the agency to be "divorced from control by the people to an extent that it implies a distinct lack of faith in democratic processes." In fact, Congress, if not Bush, should have known better. Truman's position was known before his veto. It had been articulated before the congressional committees earlier by his Bureau of the Budget witnesses. The administration wanted a director appointed by the president with a presidentially appointed board acting in an advisory and policymaking capacity. Thus the agency would be accountable to the people through the president.

In spite of the arguments that held up the founding of the National Science Foundation, the five year debate never questioned the support of science; rather it always swirled around the issue of how it should be supported. How was the ethic of pure science, with its esoteric subject matter appealing only to a few, to be supported in a nation that was traditionally most comfortable with practical goals that applied to the many? How could "best science" elitism accommodate the geographical and institutional pluralism of America? Those fundamental questions

were not answered then and are still discussed vigorously. At the time of Truman's 1947 veto, however, support of basic science research by the federal government had already spread in part to other government agencies.

The explosion of two atomic bombs over Japan in August 1945 ushered in public awareness of nuclear energy. For national security reasons, American policymakers quickly decided that this powerful energy source would continue to be guarded closely by the government. The ensuing Atomic Energy Act of 1946 restricted the use of nuclear data and effectively carved off the field of nuclear energy as an independent area of research. The Atomic Energy Commission, which assumed control of Manhattan Project facilities in January 1947, soon became a leading government scientific agency. It concentrated its support of basic research and fellowships primarily in physics.

Science--The Endless Frontier called for support of biomedical research in the new research foundation. During the war, Bush's Office of Scientific Research and Development had great success coordinating the government's sponsorship of medical research. But when the creation of the National Science Foundation ran afoul of politics in the postwar period, the Public Health Service assumed these responsibilities within its already established National Institute of Health (at the time, there was only one). Much NIH research was conducted in its own laboratories, but after 1945 the agency added a popular extramural grant program that increasingly gained from Congress sizeable appropriations and an enduring political constituency.

Bush's report also called for a continuation of military research in peacetime by the civilian-controlled organization, with close liaison with the Army and the Navy. That recommendation was based on Bush's wartime experience. When the Office of Scientific Research and Development went out of existence in December 1947, the secretaries of War and Navy created a new board to fill the void. In the meantime, the Navy quickly moved to establish close ties with the nation's research universities. It gained statutory approval for an Office of Naval Research in 1946. Although headed by a naval officer, the office had as its deputy administrator a civilian chief scientist to direct the scientific program. While the primary purpose of the office was to perform research of direct use to the Navy, the office also supported wide-ranging unclassified basic research that had little bearing on naval issues. Developing a good working relationship with the civilian science community, the office allowed results of research to be published in the open literature and pioneered in using eminent scientists to evaluate the research projects it sponsored. Thus the Office of Naval Research became a model for a government grant-making agency. The National Science Foundation later adopted many of its techniques.

So by 1950, when the National Science Foundation came into existence, there was already an extensive though disjointed government sponsored research system for the sciences. Although Science--The Endless Frontier still could be claimed as the blueprint for government supported science through a central agency, the intervening circumstances between 1945 and 1950 brought major changes in the government-science community environment. It set the stage for future difficulties. This new context, so different from 1945 when Bush's report was written, would not allow the National Science Foundation the strong central role as the major supporter of basic research that Bush envisioned. Nonetheless, the agency was in place. Only time and the circumstances of the 1950s and beyond would prove whether it would be important to basic science in America.

CHAPTER II

THE EARLY YEARS TO SPUTNIK

President Truman signed the bill creating the National Science Foundation on May 10, 1950. The act provided for a National Science Board of twenty-four part-time members and a Director as chief executive officer, all appointed by the president. Among other things, the law directed the agency to encourage and develop a national policy for the promotion of basic research and education in the mathematical, physical, medical, biological, engineering, and other sciences; to initiate and support basic scientific research in the sciences; and to evaluate the scientific research programs undertaken by agencies of the federal government. Organizationally, the Foundation could create whatever divisions were necessary to carry out its activities, but the act specified that four divisions had to be included: medical research; mathematical, physical, and engineering sciences; biological sciences; and scientific personnel and education. The latter division was responsible for scholarships and graduate fellowships.

Throughout the summer of 1950 lists of respected scientists who might be considered for appointment to the National Science Board made the rounds in official Washington. By November President Truman had named the full complement of the board. It would be a while longer before a director was named; in early March 1951, Truman nominated Alan T. Waterman, the chief scientist at the Office of Naval Research and previously a physics professor at Yale. Vannevar Bush gave perhaps the best estimate of Waterman: "He is a quiet individual, a real scholar, and decidedly effective in his quiet way, for everyone likes him and trusts him." At the Foundation, Waterman fulfilled that estimate. He served two six-year terms, retiring in 1963.

To no one's surprise, Waterman turned to former colleagues and acquaintances at the Office of Naval Research to recruit several of his principal Foundation staff. Both his deputy and general counsel had served at Navy. So did the first head of scientific personnel and education and the director of the division of biology. The only non-Navy principal was the director of mathematical, physical and engineering sciences. The agency augmented this group by recruitment from the academic community. Waterman never activated the fourth statutory division--medical science--because NIH was supporting so much research in the field. The Foundation"s small medical science program eventually was combined with biology.

Waterman assumed the agency would not have a permanent physical home as long as it was in a growth stage. Consequently, the Foundation occupied several buildings successively, with the common requirement being that the location be not too far from the Foggy Bottom area that housed the National Academy of Sciences and its National Research Council, private organizations created in 1863 and 1916 respectively. In 1951, the agency started operations in a residential structure at the corner of 16th and I Street, N.W. Later that year it moved to 2144 California Street, N.W., but it quickly outgrew that building. In 1953, the Foundation settled in the old Cosmos Club at H Street and Madison Place, N.W., with auxiliary offices in the historic Winder Building across 17th Street from the Executive Office Building. The expansion of the agency as a result of Sputnik brought another move--to 1951 Constitution Avenue in 1958. The Foundation remained there until 1965 when it moved to its present location at 1800 G Street, N.W.

Two themes dominated operations during the first years of the Foundation and both had roots in the language of the act. Officials at the Bureau of the Budget, on the one hand, wanted the agency to develop federal science policy and evaluate federal science programs throughout the government. The law, in fact, directed the agency to perform those functions. On the other hand, Waterman and the science board, dominated by academic scientists and administrators, insisted on emphasizing support for basic academic research and graduate education which were also statutory functions.

Waterman had good reason for this tack. For a young agency to become involved with evaluation of programs of other agencies would stir bureaucratic resentment, particularly from the well-established programs in the mission agencies. His experience at the Office of Naval Research warned him about that. Waterman used the argument that the law did not give the Foundation adequate authority over other agencies and departments. The Bureau of the Budget nevertheless pressured the agency on its position because it saw the Foundation, being the only agency with a mandate for general science programs, as one that could coordinate the pluralistic federal science program and help the president's budget staff resolve budgetary choices.

Waterman withstood the pressure from the budget office even as he defined the Foundation's policy role as one of advocating a research support program, improving government-university relations, and compiling reliable information on scientific research and manpower. And that role the agency pursued. Until amended in 1953, the original act limited the annual appropriation for the agency to $15 million. During fiscal year 1951 (until 1976, the federal fiscal year ran from July 1 to June 30), Congress appropriated only enough money for the agency to start administrative operations. Its first real budget began in

fiscal year 1952 and even then the appropriation was late. Although the agency asked for an amount near its statutory limit, it was shocked to receive only $3.5 million. Vannevar Bush, in Science--The Endless Frontier, had interestingly called for a first year budget of $33.5 for the Foundation, rising to $122.5 by the fifth year. But times had changed since the immediate postwar period. Basic scientific research by the early 1950s was overwhelmingly supported through the mission agencies. The Korean conflict was underway. Congress, therefore, was not willing to provide a large outlay to the new Foundation even though it had a broad mandate to support general science research.

While the budget was being negotiated, the small agency staff planned a program to support individual research projects in the mathematical, physical, nonclinical medical, biological, and engineering sciences. Approved by the board, the staff concluded that the project grant system would work best. In adopting this procedure, it followed the pattern of most of the private foundations and the Public Health Service. It thought the project grant with its non-restrictive features was best suited to achieve two agency objectives: encourage the best basic research and ensure a comprehensive research program.

Early guidance to prospective investigators suggested what should be included in the proposals in order for the staff to make an evaluation. It should contain a description of the intended research, procedures to be followed, facilities and equipment available, biographical information on the principal investigator and others participating in the research, and a budget. The proposal had to have the approval of the originating institution and be signed by an official authorized by the institution. Although an individual researcher submitted a proposal, for administrative purposes, a successful grant would be awarded to the institution to support the research of the individual. Grants would cover direct costs plus up to 15% for indirect costs.

Proposals went to the appropriate division and subsequently to the program officer responsible for either the discipline or function. The programs were generally organized by discipline in the mathematical, physical, and engineering sciences, and by sub-discipline in the biological and medical sciences (regulatory, systematic, molecular, etc.). Program officers were the agency's front line people. They had to work within budgets and always had more good proposals than they had money to support. Program officers read each proposal and arranged for external review. Generally, program officers solicited mail reviews in the mathematical, physical, and engineering sciences, and used a combination of mail and assembled panel reviews in the life sciences and later in the social sciences. From the beginning keen competition meant that only the best proposals were funded.

Program officers were also the front line decision-makers in that

they often had to select among seemingly equal proposals. Scientific merit was the main criterion. The budget alone prevented all meritorious projects from being funded; in some instances proposals were awarded but the funding had to be carried over to the next fiscal year. This created backlogs and merely increased the pressure on program officers to limit selections even more.

By supporting only the best science, the agency opened itself to criticism from levelers about lack of geographical distribution. The largest number of early awards went to a few geographically concentrated colleges and universities. Although the award statistics also revealed some diversity, James B. Conant, the first chairman of the science board, captured the essence of the Foundation's philosophy: "In the advance of science and its application to many practical problems, there is no substitute for first-class men. Ten second-rate scientists cannot do the work of one who is in the first rank." That first-class scientists were predominantly at only a few institutions did not stop the critics.

Program officers reviewed proposals not only to fund individual research projects, but also supported scientific conferences and symposia as well as travel of scientists to international meetings and congresses. Although these projects took only a small part of the Foundation's budget, the agency considered them important enterprises that would add to the prestige and understanding of American science.

Beginning in the late 1940s a new Red Scare known best as "McCarthyism" brought a pallor of uneasiness over the nation's universities and government agencies. "McCarthyism" was due largely to the onset of the Cold War with the Soviet Union, which made security an important national issue. Particularly questioned was the loyalty of scientists who worked for the government on weapons projects, and the issue was underscored by the stripping of the security clearance in 1954 from one of the nation's most noted and respected scientists, J. Robert Oppenheimer.

When Senator Joseph McCarthy questioned the loyalty of a number of academic scientists applying for research grants from the National Institutes of Health, Foundation officials worried that its applicants might be next. Consequently, the science board adopted a policy in 1954 announcing that awards of research grants would continue to be based on the investigators' competence and the merits of their research proposals. No security checks would be instituted for prospective grantees, in part because the agency supported only unclassified research and in part because the awards were made to the sponsoring institutions, not to the scientist directly. The Foundation's only condition stated that it would not knowingly support the

research of an avowed communist. The policy was a bold move given the climate of the times and the fact that McCarthy was at the height of his power. But it worked and two years later President Dwight Eisenhower made the Foundation's example government-wide policy.

By its charter, the agency also had a mandate to increase the number and quality of scientists in the nation--the research base. Very early the Foundation started a fellowship program for graduate students and postdoctoral scientists. It announced the first awards in 1952. The agency contracted with the National Research Council of the National Academy of Sciences to establish screening panels to group the fellowship applicants on merit. From the groups the program staff in the Office of Scientific Personnel and Education made its recommendations to the Foundation director. The task was difficult because the staff had to spread the awards among the disciplines as well as to meet the statutory requirement of wide geographical distribution. Once selected, however, a fellow could choose where he wanted to study. This suited Foundation officials. Since most fellows elected to study at a small group of prestigious schools, the agency's sharpest critics cried elitism. The Congress, however, was generally satisfied because each state was at least represented. The agency held fast to the principle of freedom of choice.

To counter the criticism, in 1957, the Foundation expanded the program by creating a cooperative graduate fellowship program, best known later as traineeships. The awardees were graduate students in situ. This resulted in increasing the number of fellows at a larger group of universities without violating either the freedom of choice principle or the principle of support for the best scientists. The traineeship program did not have the same prestige, however, nor did it last. Traineeships came and went in response to national needs.

The high standards for selection of fellows set the Foundation's program apart and attracted national attention. The agency also published the names of applicants who achieved honorable mention in the fellowship selection process. Often these very qualified people subsequently were supported by fellowship programs from other institutions and agencies or selected as teaching assistants in university science and engineering departments.

Debate over including the social sciences in the programs of the Foundation had punctuated the legislative history of the statute. Those disciplines finally were permitted but not required under the rubric of "other sciences." In the early 1950s, it took the patient diplomacy of a few social scientists as well as pressure from congressmen to overcome the opposition of most of the staff and the science board to integrate into established agency programs some social science disciplines that converged with the

natural and life sciences. Anthropology, human ecology, and demography, for example, were included in the biological sciences division and in 1955 the Foundation placed a program for socio-physical sciences in the mathematical, physical, and engineering sciences division. That program included mathematical social science, human geography, economic engineering, statistical design, and the history, philosophy, and sociology of science. But not until 1958 did the board approve formal support of the "other sciences" by creating an office of social science that brought all the disciplines together. Even though they had to meet rigorous standards of "objectivity, verifiability, and generality," a great many scientists opposed including the social sciences. One board member commented in 1958: "...we have to face up to the fact that the social sciences--except for a few extremely limited areas--are a source of trouble beyond anything released by Pandora."

The early and mid-1950s saw preliminary work done toward moving the agency into an area soon referred to as "big science," which eventually would take a sizeable percentage of the Foundation's budget. New centers for radio and optical astronomy and for atmospheric research required facilities and instruments so costly that only the federal government had the resources to build, equip, and operate them. The Foundation, under its charter, could not directly operate research laboratories, so these facilities were managed under contract by associations of universities which had special competence in the sciences concerned. The facilities, however, were open to all qualified researchers. Negotiations leading to contracts for these centers brought accusations of monopoly along with some fear that the Foundation's move into "big science" would cause the individual project grant to lose its share of funding.

Designation of the Foundation as the funding agency and coordinator of American participation in the International Geophysical Year of 1957-58 also brought the agency into new areas of large-scale science in global atmospheric and oceanographic research and worldwide ecological studies. The Foundation's main interest during the designated year focused on research in Antarctica. It resulted in a continuing program there with the Foundation as the lead agency. In 1959, the United States concluded a treaty with the other nations engaged in Antarctic research that reserved the continent for peaceful and scientific research.

Even before the Soviets put Sputnik I in orbit on October 5, 1957, the Foundation and American scientists had been concerned with the state of American science vis-a-vis the Soviet Union. Fiscal years 1957 and 1958 witnessed substantial increases in the Foundation's budget. Sputnik dramatically underscored the Soviet-American competition. While the satellite provided the first human reach beyond the planet, it symbolized in America the need

for improving scientific education and basic research, needs already known to the scientific community. While that was the importance of Sputnik, equally important was the fact that the nation had already taken steps in the postwar period to build a scientific establishment that could meet the challenge of this more visible scientific competition. That became the legacy of the early years to Sputnik.

CHAPTER III

FROM SPUTNIK THROUGH THE GOLDEN AGE, 1957-1968

Sputnik once again elevated the word "competition" in the language of government officials and the American public. Sputnik threatened the American national interest even more than the Soviet Union's breaking of America's atomic monopoly in 1949; indeed it rocked the very defense of the United States because Russia's ability to place a satellite into orbit meant that it could build rockets powerful enough to propel hydrogen bomb warheads atop intercontinental ballistic missiles. Perhaps more importantly, however, Sputnik forced a national self-appraisal that questioned American education, scientific, technical and industrial strength, and even the moral fiber of the nation. What had gone wrong, questioned the pundits as well as the man in the street. They saw the nation's tradition of being "Number One" facing its toughest competition, particularly in the areas of science and technology and in science education.

With its ties to the nation's research universities, the Foundation of course became a key player in the unfolding events during this trying time. An indication is shown by the large increase in Foundation monies for programs already in place and for new programs. In fiscal year 1958, the year before Sputnik, the Foundation's appropriation had leveled at $40 million. In fiscal 1959, it more than tripled at $134 million, and by 1968 the Foundation budget stood at nearly $500 million. Highlights of this phase of the agency's history cannot be told in a vacuum, however, but must be placed within the broad context of American political happenings.

The Congress reacted to Sputnik with important pieces of legislation and an internal reorganization of its own committees. Taken together, the action announced that America would meet the Soviet competition. The National Aeronautics and Space Act, more than any other post-Sputnik law, had great impact on increasing federal funding of scientific research and development. Signed by the president in July 1958, the law created the National Aeronautics and Space Administration (NASA) and gave it responsibility for the technological advancement of the space program. NASA became a major contracting agency and boosted tremendously the extramural research support of the federal government. NASA not only symbolized America's response to the Soviet challenge, but also dramatized the federal role in support of science and technology.

Within the Congress, members reorganized to form permanent

standing committees to deal with the space issue and with science and technology in general. The reorganization provided the Congress with a focal point not present before for science and technology issues. For the first time, too, the legislative branch gained a professional staff trained in science and technology. In mid-1958, the House created the Committee on Science and Astronautics while the Senate established the Committee on Aeronautical and Space Science. Although the latter committee limited itself to NASA and space issues, the House committee's jurisdiction extended over the space program and the nation's general science policies. This included oversight of the Foundation.

Sputnik raised questions about the ability of the nation's education system to compete. Congress responded with the National Defense Education Act of 1958. It emphasized science education and became a significant part of the country's science policy. The act provided a student loan program, aid to elementary and secondary school instruction in science, mathematics and foreign languages, and graduate student fellowships. While it was directed mostly at students rather than institutions, and was administered out of the United States Office of Education, the law had an important impact on federal support of science education. Both its fellowships and its institutional benefits followed geographic distribution patterns rather than the competitive elitist format typical of Foundation programs. Of even greater significance, however, the act opened the way for future legislation that redefined many of the relationships between the federal government and the education community.

The National Defense Education Act of 1958 also directed the Foundation to establish a Science Information Service. The agency always considered the dissemination of scientific information as one of its main support functions. It had, since 1953, run the National Register of Scientific and Technical Personnel, a function assumed from the Office of Education. The new Office of Science Information in the agency provided both research and administrative support programs that covered storage and retrieval systems, mechanical translation, support for scientific publications, scientific data centers, and collection of foreign science information. The frequent notation, "Source: National Science Foundation" under graphs, charts, and tables in a wide variety of books and articles attested to the importance of the function.

As early as 1953, the Foundation had supported a few summer institutes for college teachers, but was extremely hesitant to start similar enterprises for high school teachers. It reluctantly did so in 1954 with one small institute, following in the footsteps of successful institutes sponsored by industry, universities, and private foundations. This slowly broadened in the years before Sputnik, as reports of Soviet schooling in

science and mathematics raised queries in Congress about American support of education in the hard sciences. Although Foundation officials harbored reservations about its authority to support high school teacher training, and furthermore did not give it a high priority, Congressional pressure in this area taught them that Congress could and would set priorites for the agency through the budget process. By the summer of 1957, for example, there were institutes in all but five states. That fall Sputnik brought a huge boost in the Foundation budget for teacher institutes along with a chance to try other educational projects, including adoption of new curricula in physics, biology, chemistry, and mathematics.

Long before Sputnik, science policymakers were concerned with the state of research facilities and instrumentation, particularly at the nation's colleges and universities. The 1947 Steelman Report (the report of a temporary presidential board, headed by Truman assistant John R. Steelman, that addressed the status of American science) recommended that federal aid be given to universities for construction of facilities and purchase of expensive equipment. The report noted that distribution of surplus government property from World War II made a beginning in this direction, but that a more permanent solution had to be found. As a harbinger of what was to come, in 1956, Congress established a Health Research Facilities Program within the National Institutes of Health. It provided grants for up to 50% of the cost for construction, remodeling, and equipping laboratories for health-related research mostly at medical schools.

Early in 1956, the Bureau of the Budget asked the Foundation to report on the current status and future needs for research facilities and to ascertain the government's role in providing assistance. The Foundation's June 1957 report, "Federal Financial Support of Physical Facilities and Major Equipment for the Conduct of Scientific Research," found three conditions that affected the state of college and university science laboratories. First, the report emphasized the current deterioriation of the nation's laboratories through long use, a condition exacerbated by a moratorium on new construction during World War II and current rapidly rising construction costs. Second, the nation was about to enter a period of greatly expanded college enrollment (the post-World War II "baby boom") that would have a tremendous impact over the next few years on the science laboratory needs. Third, the accelerating pace of scientific development and innovation tended to shorten the useful life of much of the equipment and instrumentation presently in place.

Since involvement by the federal government in aid to college and university education had always been a controversial issue, the report recommended a government policy of proceeding cautiously to support only facilities with a predominantly research

character and to refrain from supporting facilities with an educational character (the report left unstated how to separate the two). The Foundation underscored that the first responsibility of the colleges and universities should be to seek funds from other than federal sources, and it set conditions before federal support would be considered: that there be an urgent need, it be in the national interest, and funds from other sources not be available. Consequently, the launching of Sputnik a few months later "merely" became a force that propelled the federal government more rapidly along a course that the Foundation had already recommended.

The Foundation's institutional programs, as they came to be called, outlived the immediate crisis of the Sputnik period and expanded into the "Golden Age" of science funding in the Lyndon B. Johnson administration. While Sputnik provided the thrust for the early programs, the burgeoning baby boom college population in the middle years of the 1960s, coupled with a wider role for the federal government in education under President Johnson's Great Society program, became the continuing driving force for many of the Foundation's programs.

In 1963, Congress passed the Higher Education Facilities Act and two years later it was incorporated in the broader Higher Education Act of 1965 as part of the Great Society program. Run by the Office of Education, both acts provided grants for general facilities construction at colleges and universities. Science facilities were a substantial part of the outlay, but the important point is that with passage of the two laws, a major general college building program began, supported largely by the federal government. New and continuing Foundation institutional programs not only fit this milieu but benefited from the larger Great Society philosophy.

The Foundation had started in 1960 with its Graduate Science Facilities program. It provided matching grants to help graduate degree granting universities build or renovate their research laboratories. After 1962, most of its funds went toward new construction. The agency's Institutional Grants for Science, started in 1961, broadened support for already established or first tier institutions through a formula based on awarded grants. In 1964, the Foundation launched its Science Development Grants, better known as the Centers of Excellence program. Spurred on by pressure from the executive branch, the agency wanted to increase the number of institutions of recognized excellence in research and education in the sciences. Criticism had been heavy for some time for the agency to redistribute science funding. By deliberately excluding the top twenty elite universities and concentrating its funding on second tier institutions, and by emphasizing geographical dispersion, the Centers of Excellence program not only responded to outside criticism but reflected the philosophy of the Great Society.

Relatively large awards were made to hire new faculty, support graduate students, and construct new facilities. In 1966, the agency broadened the program to include Departmental Science Development awards and Special Science Development awards to improve those subunits at many of the nation's second tier universities.

Like the construction funded under the Higher Education Acts, most of these agency programs outlasted the Great Society but were scaled back or eliminated in the more austere budgets of the early 1970s. Later surveys showed that in spite of the large increase in construction at the nation's colleges and universities, the increase in the baby boom college population apparently outdistanced construction. While the construction improved the infrastructure, student crowding along with continued use of the new facilities and instrumentation still meant a future need at a lot of places.

Big science projects accounted for a large part of the Foundation's increasing budgets during this period. And despite concerns that such enterprises might affect the budgets for the Foundation's traditional individual researchers, those fears proved unfounded. Expanding astronomy centers, the Antarctica program, and a new atmospheric research center were well-managed enterprises that contributed much scientific knowledge through basic research and continued to receive sizeable appropriations. It is true that Project Mohole, a cleverly devised attempt to gain knowledge of the earth by drilling through its mantle from an ocean platform, became a management and financial albatross before Congress terminated it in 1965-66. Mohole opened the way, however, for other deep ocean sediment investigations. The Deep Sea Drilling Project began in 1968 and over the years revealed much new evidence about the theories of continental drift, sea floor spreading, and the general usefulness of the ocean basins. The program also became a model of international cooperation as several foreign countries joined the operation.

The Foundation's role in federal science policymaking changed during this era. Alan Waterman had avoided the difficulty of attempting to coordinate federal science activities during the early years. After Sputnik, President Dwight Eisenhower's appointment of the first presidential science adviser unofficially relieved the Foundation of some of its coordinating responsibility. Eisenhower also established the President's Science Advisory Committee in 1957, consisting of a group of eminent scientists who collectively advised on a part-time basis. Thus science policy had a voice for the first time at the White House level. In 1959, the president took the advisory committee's advice and created a Federal Council for Science and Technology, made up of the heads of all federal agencies responsible for scientific research and development. The nine-member council was to consider research-related problems that cut across the

missions of their agencies and make recommendations to the president. Eisenhower and President John F. Kennedy appointed strong science advisers and the advisory committee rendered good service. The council, however, proved somewhat ineffective, mirroring the view Waterman had so long taken about coordination of the government's pluralistic science and technology policy.

Official notification that the Foundation would no longer be responsible for coordination of federal science policy came in 1962. In June, President Kennedy issued Reorganization Plan No. 2, an executive directive that added to the Executive Office of the President a permanent Office of Science and Technology headed by the science adviser. The plan simultaneously relieved the Foundation of its government-wide evaluation and policymaking functions by transferring them to the new unit.

Throughout his two-term tenure, Waterman had vigorously adhered to a policy of support primarily for basic research in the face of growing pressure from several quarters to support applied research as well. In 1958, for example, Congress forced the agency reluctantly to supervise the government's weather modification program, a definite applied science endeavor. But for the most part, Waterman and his successor, Leland J. Haworth, who served from 1963 to 1969, believed that the first obligation of the agency should continue in the direction of basic research in the natural sciences. A physicist like Waterman, Haworth came to the Foundation from a position on the Atomic Energy Commission and prior to that he served as director of the Brookhaven National Laboratory.

In the aftermath of Sputnik, Congress during the 1960s became more involved with the nation's science policy. Out of that concern, the House Committee on Science and Astronautics established a Subcommittee on Science, Research and Development, best known as the Daddario Committee after its chairman, Democrat Emilio Q. Daddario of Connecticut. In 1965 it began an extensive review of the Foundation's charter that culminated in 1968 with amendment of the Foundation's basic law.

Joined by Senator Edward M. Kennedy of Massachusetts as Senate sponsor, the Daddario-Kennedy amendment required annual review of the Foundation's programs before both the House and Senate science subcommittees and annual authorization for its appropriation. Continuing authorization had been provided prior to the amendment. Organizationally, the deputy director and four assistant directors were to be appointed by the president. Up to then, only the director had to meet that requirement, while the assistant directors were appointed by the director. The amendment also designated the social sciences as a field eligible for Foundation support, elevating it from the vague "other sciences" category in which it had languished since 1950. But the most controversial part of the amendment authorized the Foundation to

support applied as well as basic research. It hearkened back to the arguments of the postwar 1940s over the creation and purpose of the Foundation. The Daddario-Kennedy amendment considerably changed the Foundation, but it remained as the only general purpose science agency in the federal establishment that supported basic research.

Shortly before his untimely death, President Kennedy addressed the National Academy of Sciences on its hundredth anniversary. He warned the gathering that "scientists alone can establish the objectives of their research, but society, in extending support to science, must take account of its own needs." The elitism embodied in the science-government relationship dating to the post-World War II years had to give way to a broader, more democratic base. Kennedy's successor, very much a modern democrat and leveler, a graduate of non-elitist Southwest State Teachers College in Texas, probably did more to democratize that relationship through his Great Society philosophy than he is generally given credit for. In 1965 Lyndon B. Johnson told his cabinet that it was "very much the concern of the Federal Government" through funding of basic research to be sure that the nation's "future must rest upon diversity of inquiry as well as the universality of capability." So by bringing a Golden Age to science funding while insisting that those funds be distributed widely, Johnson made his impact.

Toward the end of his administration, however, the Golden Age came to an end. Increased spending on the Vietnam War coupled with outlays for other domestic programs forced reductions in civilian research budgets. The Foundation's budget increases of the previous few years leveled off. The next several years would see the Foundation still supporting basic research as its major endeavor, but also would see it embarking on new ventures in untried areas.

CHAPTER IV

TUMULTUOUS TIMES, 1968-1976

Changes in the charter of the Foundation through the Daddario-Kennedy amendment coupled with events throughout the government and the nation made the period from the late 1960s to the mid-1970s a tumultuous time for the agency. While the Foundation's mission of support to basic research in science and engineering and assistance to science education remained, it already had become evident that the Foundation could not live in an isolated environment unaffected by the happenings around it. Whether the Foundation wanted the exposure or not, issues focused attention on the agency.

Political matters loomed large in the early years of the Richard M. Nixon administration. The continuing Vietnam war with its politicizing of students and professors, additional spending on the previous administration's entitlement programs, and emergence of a new national interest in the environment all either indirectly or directly affected the Foundation. At the very least, the first two diverted possible federal funds from Foundation programs while the environmental movement provided a context for the growing interest in the applied research that the agency could conduct under its new legislation.

The year 1969 brought new leadership to the Foundation. President Nixon selected William D. McElroy as the agency's third director. A biochemist who headed the biology department at Johns Hopkins, McElroy took on the directorship after a political imbroglio over an earlier candidate embarrassed the Nixon administration. Cornell scientist Franklin Long had been tentatively selected to replace Leland Haworth, but became unacceptable due to his opposition to the administration's anti-ballistic missile program. The heretofore non-political selection of a director appeared to be violated although the administration somewhat redeemed itself in its choice of McElroy, a registered Democrat who claimed he voted as an independent most of the time.

McElroy made it clear when he took the reins of the Foundation in the summer of 1969 that he would operate differently than had his predecessors. He proclaimed a goal of increasing the agency's appropriation from its $400 million plus level to $1 billion within three years. He would not forsake basic research, which remained the mainstay of the agency's business, but clearly wanted to use some of the budget to move in different directions. When he resigned in 1972, his billion dollar goal had not been reached, but the agency's appropriation had increased to $650

million and some of the changes he sought were just beginning to be implemented.

McElroy wanted to rid the Foundation of the passive role that he thought the agency had taken to that time. Aware that the mood of the country had become mistrustful of science in general, he sought to change that image at least in terms of what the Foundation could do about it. To get larger appropriations, McElroy began to woo Congress aggressively. He also worked more closely and often directly with the Office of Management and Budget to shape the Foundation's outlays and programs. At times, this placed him in an uncomfortable position with the science board, which traditionally had interacted closely with the director on agency program development and internal policies. The increased role of the Office of Management and Budget in setting Foundation policy through budget decisions had a long-lasting effect on the agency.

A program that provided one of the biggest controversies in the history of the agency blossomed and faded during the period 1969-1977. Research Applied to National Needs, better known as RANN, was an operation that stemmed from the Daddario-Kennedy amendment giving the agency authority to conduct applied research. In response to the amendment, in 1969, the Foundation established a modest applied research program, named Interdisciplinary Research Relevant to Problems of Our Society (IRRPOS), to which Congress appropriated $6 million in fiscal year 1970. At the time, both the newly-appointed McElroy and the Bureau of the Budget (soon to be renamed Office of Management and Budget) had shown interest in having the Foundation direct attention on socially relevant scientific research. IRRPOS, however, reflected the traditional approach of the agency by responding to proposals from the scientific community rather than the agency stimulating specific research proposals. The emphasis of the awarded grants was in the areas of environmental quality and urban growth and management. IRRPOS operated for two fiscal years when it expanded into RANN.

In late December 1971, following a failed attempt to design a comprehensive "technical innovation" initiative for a presidential message on science, the Office of Management and Budget told McElroy that if the agency could produce a major applied research effort that would focus science resources on national problems, the Foundation could increase its budget by $100 million. In part, the administration wanted to stimulate a faltering economy and had directed that most agencies increase spending during the 1972 budgetary year. In return, the Foundation agreed to phase out its institutional programs and a major portion of its educational programs. The Office of Management and Budget directed that about half the increase could be used for applied research and the remainder would be used to cope with the agency's increased responsibilities under the Mansfield amendment. That 1970 piece of legislation made it

unlawful for the Defense Department to fund basic research unless it was clearly related to a military function or operation. The amendment nonetheless stressed the need for such research and ordered the Foundation rather than the defense agencies to provide it.

RANN was the Foundation's response to the Office of Management and Budget initiative and it officially lasted until 1978, when it was reorganized into a smaller applied research directorate. During that time, nearly $500 million was appropriated for the program. From the beginning RANN was different. It was organized around designated problems rather than science disciplines and its criteria and management were foreign to previous Foundation management practices. It addressed many of the domestic problems that were in the headlines of that era: pollution, transportation, energy, and other urban and social difficulties. RANN attempted to link industrial enterprises and academic research, with the hope of industry eventually supporting parts of the program. In retrospect, RANN recognized the relationship of basic science to international competitiveness. But criticism abounded. It came from segments of Congress, from other agencies, and particularly from the science community (including the science board and most Foundation staff), which feared that RANN would drain funding from the traditional aspects of basic science.

Director McElroy and his successor, H. Guyford Stever (1972-1976), argued that a large share of the monies for RANN actually involved basic research in support of the various applied research projects funded. Such arguments never appeased some of the most vociferous members of the basic research community. The program began to phase out in 1975 and 1976, when parts of RANN went to related in-house disciplines while about two-thirds of the program that dealt with energy was transferred to the Energy Research and Development Administration. RANN, nonetheless, was a harbinger of the Foundation's effort of a decade later to link academic basic research with industry to help stem the crisis the nation faced in international competitiveness.

By the end of his first term, President Nixon had become dissatisfied with his White House science advisory group. Its members sometimes disagreed with him on issues important to his political objectives. The two most notable examples were the supersonic transport and the anti-ballistic missile. Some members of the President's Science Advisory Committee also dissented publicly over the administration's conduct of the war in Vietnam. It was all part of a growing political consciousness particularly tied to the nation's colleges and universities that dated back to the mid-1960s. It became obvious that the White House science apparatus was beginning to lose the effectiveness it had earlier, but it still came as a surprise to the science community when the president announced a reorganization plan in January 1973.

Nixon abolished, effective on July 1, the Office of Science and Technology. At about the time he announced the plan, the president also terminated the post of science adviser and accepted the pro forma resignations of members of the President's Science Advisory Committee. The role of science adviser to the president would be assumed by Guy Stever in addition to his job as director of the Foundation. The move quickly brought hearings by the Congress and a general uproar from the basic science community that science had been deprived of substantial status and influence in the nation's top ruling circle.

The administration defended the move primarily through testimony by Stever and Raymond Bisplinghoff, the deputy director of the Foundation. The defenders used political accountability as the fundamental argument. Under the former organization, the White House science and technology apparatus appeared politically accountable only to itself and the group of specialists it effectively represented. Under the new arrangement, Stever argued, the science adviser, appointed by the president and approved by the Congress, could respond to growing pressures that friends of basic science were needed in other areas. Furthermore, the president could draw upon the only federal organization that had a mandate covering all of science and also was responsible to the president. In effect, the argument continued, the reorganization restored the original mandate of the Foundation, by making the agency and its director responsible for national science policy advice. The basic science community and critics of the Nixon reorganization, however, did not accept the administration's arguments.

Among many suggestions, a National Academy of Science report in 1974 epitomized the basic science community's position. It advocated that scientific expertise should be heard above the din of politics. Specifically, it suggested a three-member council for science and technology. The council would be a part of the president's inner circle and would provide balanced judgments on issues of science and technology. The report had many supporters, representing mostly the postwar science establishment in Washington that had lost its insider position by the Nixon reorganization. No one criticized Stever personally, but many suggested that wearing both hats was too much of a burden for one person to assume.

Stever knew he needed help to perform both tasks. He established a science and technology policy office within the Foundation to assist him in his advisory duties. He brought in some new people, but several Foundation staff people were also used on an ad hoc basis. The administration required research and development assistance in the wake of the 1973 Arab oil embargo crisis. The Foundation staff helped out. In addition, the staff was heavily involved in scientific exchanges with the Soviet Union during

this period. Altogether, the situation taxed the agency greatly.

When Gerald Ford became president in the summer of 1974, he wanted restoration of a separate White House science apparatus. Ford insisted that any new arrangement, however, be established by legislation rather than by executive directive. After two years of negotiation, during which time the Foundation continued its dual role, the Congress created a new Office of Science and Technology Policy (OSTP) within the Executive Office of the President. The head of OSTP would be the science adviser to the president. Ford selected Stever for the office. The statute did not reestablish a permanent advisory committee, but it created a two-year President's Council on Science and Technology (President Carter later dissolved it). By then a new context appeared to be developing. Peace had returned to the nation and the political unrest on the campuses had subsided. This bettered the relationship between academic science and the administration and helped to overcome the earlier furor over the 1973 reorganization.

The turmoil at the head of government science policymaking did not hide controversies in the agency. In addition to the on-going debate over RANN, a new issue flared in the combined fields of science education and the social sciences. One social science educational project in particular, among the many that the Foundation had helped create and disseminate since 1957, generated a controversy that brought national attention to the agency. "Man: A Course of Study," had been developed with Foundation funds as a course in human behavior for 5th grade students. By the time the controversy reached the national level in 1975, over 1700 elementary schools in 47 states offered the course. Among its critics, Arizona Congressman John Conlan charged that the course distorted basic family values. His criticism eventually brought an attempt within the House of Representatives to require that all Foundation projects gain final approval by Congress before being funded. Fortunately for the Foundation, the proposal failed, but it highlighted for the agency the ever-present oversight authority of the legislative branch.

The controversy over "Man: A Course of Study" underscored best the vagaries in doing work connected with social science values. The agency also has been criticized at times for its support of other particular research projects. To some, they seemed to be frivolous, obtrusive, objectionable, quixotic, a waste of taxpayer's money or all of the above. With the exception of its stand in the "Man: A Course of Study" controversy, the agency's position to its critics has been not to become defensive, but to explain as clearly as possible the nature of research in basic science and engineering. For the most part that strategy has worked, although at times it has made life uncomfortable for members of the Foundation staff.

Throughout the period, budgets increased for the varied programs of the Foundation. A ruinous inflationary trend also set in, however, that made real gains nearly impossible. This had a grave effect particularly on both facilities and scientific instrumentation. The agency did manage to support such big ticket items as new ships for the oceanography and ocean drilling programs and the Very Large Array facility for radio astronomy. But as monies became scarce due to a combination of inflation and the phase-out of federal facilities programs, Foundation program officers generally encouraged support of people over instrumentation and facilities. Consequently, academic institutions tended to postpone new or renovative construction and the replacement of expensive instruments. Rapid changes in instrumentation due to new technologies compounded the situation. By the end of the period many scientists were worried about the quality of instrumentation and what that held for the future of American science.

In spite of the turmoil of the period, the fundamental mission of the Foundation remained unchanged. Traditional support of basic research continued to be the mainstay of the Foundation's programs, and through such support new advances were made in all the fields of supported science. More institutions successfully competed for grants, which was a credit to the Foundation and also helped to stifle the earlier criticism about geographic distribution. No one questioned the place of the federal government as the principal patron of basic research in the nation. Budgets and competing priorities for scarce federal dollars, however, made the leaders of the agency wary about the future. As scientists and as bureaucrats, they recognized, too, that the annual agency budgets had to be fitted to the priorities the administration placed on support of science within the broader context of national goals and aspirations.

CHAPTER V

NEW CONCERNS; NEW OPPORTUNITIES, 1977-1985

Just as the earlier years of the Foundation's history could not be viewed in a vacuum, so the more recent period must be treated the same way. Two circumstances influenced the Foundation during the period leading to the present. First was the attitude toward basic science taken by the two administrations that occupied the White House during these years. The second condition was the overwhelming effect of the economy on the federal budget throughout the period. Its significance continues beyond the ending date for this short history.

At first glance the administrations of Presidents Jimmy Carter and Ronald Reagan appeared to be dissimilar, and in many ways they were. But they dovetailed in one important tendency. The Carter presidency, the first Democratic administration since 1968, did not fit the liberal image of its Democratic predecessors. The nation had changed its political ideology considerably and by 1976 had moved toward the conservative side of the spectrum. Carter, who came from the moderate right side of the Democratic Party, perceptively rode the changing political environment to victory against his similar moderately conservative opponent, Gerald Ford. Carter campaigned against the Washington bureaucracy and the entrenched interests that he perceived lurking there. Once in office, he attempted to reduce the size of the federal establishment. While he was less than entirely successful, his effort symbolized a trend in the nation away from the big government of the New Deal-Great Society era. By the end of the Carter administration, his position on a smaller role for the federal government became so much in the mainstream of political thought that it was not an issue in his 1980 defeat by Ronald Reagan. In fact, the Republican candidate highlighted that position as something for which he also stood.

Both presidents also found common ground on areas in which the federal government had a major responsibility. National defense is the element most often underscored, but what is frequently overlooked is that the major buildup of the armed forces began in the Carter administration and was just intensified by Reagan. Likewise, both administrations looked upon support of basic research as a responsibility of the federal government, although for different reasons. Carter, trained as an engineer, viewed basic research as an investment in the nation's future and his administration sought to provide real growth in expenditures at the Foundation and in mission agencies that had basic research programs. The Reagan administration also believed strongly in

research support, but the rationale changed somewhat: pure science should strengthen national defense and should contribute to economic growth by making the nation more competitive in a high technology world. Where the two administrations differed was in the area of applied research. There the Reagan people believed that federal support should be supplanted by greater private sector funding.

Support of basic research, however, was largely determined by the state of the economy. It was the primary political issue during this time, and both the Carter and Reagan budgets affected the programs of the Foundation. High inflation combined with somewhat stagnant productivity caused federal budgets to show increasingly large deficits. Even though the Foundation's annual budgets increased in sizeable amounts during the Carter years, real gains were offset by inflation.

The Reagan administration took drastic budgetary measures in non-defense areas to reduce the federal deficit while at the same time remove the government from activities it thought more appropriately belonged to other sectors. Although basic science remained an area that the administration supported in its overall budget, parts of the research spectrum were targeted for reduction. The administration cut the Foundation's budgets for fiscal years 1981 and 1982, with particularly hard hits aimed at the social sciences and science education. In both 1982 and 1983, Congress added funds to the president's request. For the first time, the Foundation's budget went beyond the billion dollar level in fiscal year 1983.

During the Ford-Carter-Reagan administrations, the leadership of the Foundation changed frequently with no director serving a full six-year term. Richard Atkinson, a psychologist who had been deputy director under Stever, assumed the directorship in June 1977. He left in July 1980 to become chancellor of the University of California at San Diego. John B. Slaughter suceeded Atkinson, but remained at the Foundation only until 1982 when he became chancellor at the University of Maryland. A physicist from the Los Alamos National Laboratory, Edward A. Knapp, served the next two years. He resigned to return to Los Alamos. President Reagan appointed the current director, Erich Bloch, in September 1984. An engineer recently retired from an executive position at IBM, he is the first director to come from the corporate community.

Within the reduced government, stringent economy context of the early 1980s, the Foundation dealt with issues that moved it in new directions and kept it at the forefront of science and engineering activities. One of the particular areas emphasized was the role of engineering in the agency's programs. Engineering science had been a discipline supported by the Foundation from the beginning of the agency's history, but it never received a lot of funding because most engineering activities were applied

in nature. After the change in the statute in 1968 allowing the agency to support applied research, several short-term engineering activities were supported under IRRPOS and RANN, while the long-term high-risk engineering science program was lodged in the directorate for Mathematical and Physical Sciences, and Engineering.

In the late 1970s, looking to new ways to stimulate economic growth and competitiveness, the Foundation studied expanding its support of engineering sciences. A small division since 1964, in 1979, the Foundation elevated engineering to a separate directorate although the applied science programs were attached to it. Nonetheless, the agency recognized that engineering was different from science in style, traditions, and university institutionalization. In 1981 the applied science programs were distributed to other directorates. The Foundation further recognized engineering that year by including it alongside science in the Science and Engineering Education directorate. The usual cries were heard from segments of the research community that such emphasis would cause the engineering budget to grow at the expense of science. But the net effect removed the heat from Congressional bills to create a separate National Engineering Foundation.

Because engineering supports and interacts with several disciplines, the engineering directorate moved to capitalize on this by establishing an office of interdisciplinary research in 1981. The Foundation, meanwhile, asked the National Academy of Engineering to examine ways in which the agency could better support cross-disciplinary research. The Academy's 1983 report recommended establishment of engineering research centers, composed of larger groupings of researchers focusing on both research and education, as a way for scientists and engineers to build on one another's work. The agency developed a grant program to start the centers based in part on the Academy's guidance. In addition, the Foundation wanted the centers to provide a stronger link between academe and industry. It also hoped the centers eventually would become self-supporting. In 1985, the agency made the first six awards, ranging from a center for robotics systems in microelectronics at the University of California at Santa Barbara to a center for biotechnology process engineering at the Massachusetts Institute of Technology.

The Reagan administration greatly reduced the Foundation's budget in fiscal years 1981 and 1982 in the areas of the social sciences and in science education. Both of these areas had always received a smaller share of funds than the physical and life sciences, but they were particularly susceptible to budget cuts under the new administration's philosophy. The administration did not consider social science as an area that supported the long-term economic health of the nation. The elimination of science education fit the philosophy of relinquishing the federal government's role in

an area that it thought rightfully belonged to the state and local sectors. Sustained argument with officials of the Office of Management and Budget by the science board and the director, coupled with intense lobbying by the social science and science education research communities kept funds for those areas from being totally removed. Some modest increases resulted in these programs in later years.

The administration recognized that the national interest of the United States was reflected in the ability of the nation to compete in a high technology world. The Foundation, as the only agency providing general science support, has increasingly found itself at the cutting edge of that effort. New areas of research policy are in the offing in science and engineering and in education. Since 1982, the administration has advocated sizeable expenditures in the Foundation's programs, especially in the physical and life sciences. The agency has also expanded its relationship with industry and state and local sectors, areas not entirely familiar to an agency accustomed to doing business mostly with the academic research community. At the same time, the agency has encouraged its academic constituency to look at industrial knowledge that would be applicable to both industry and science. All this has provided more visibility to the Foundation as the nation embraces high technology as a main solution to some of its national problems. It is a role the agency has shunned throughout its short history, preferring instead to do its job in the wings rather than close to center stage. How well the Foundation adapts to its changing place in the government establishment and in the expanded world of academic and industrial science and engineering will test all parts and traditions of the agency.

What broad themes, then, does this short survey of the history of the National Science Foundation provide the reader? To start, one would be wise to read or reread Vannevar Bush's classic short report, Science--The Endless Frontier. What Bush wanted to convey about the role of basic research in the progress of American science and technology is as appropriate today as it was in 1945. He emphasized that the frontier of science is always present and in keeping with the American tradition should be exploited for the good of the nation. He wrote that scientific research was tied to the nation's quest to avoid economic dislocation as well to create a reservoir of "scientific capital" so that it could remain at the forefront of scientific discovery. Bush argued convincingly and articulately for government support of science through an agency committed to pure science. His theme recurs throughout the agency's history and is particularly prescient in today's environment.

The larger context in which the agency's programs and policies

developed are important to keep in mind. No agency operates in a vacuum. What happens in the larger world often drives an institution in a certain direction or at least causes it to vary its course. World War II, for example, affected how policy makers viewed government support of basic research. That event can claim a role as the handmaiden of the Foundation. The Soviet launching of Sputnik had a major impact on the agency, as did the expanding vision of government in America encompassed by the policy makers in the Great Society. Both events helped solidify the ties between the agency and the academic science community. The Great Society environment also provided the context in which the Foundation took on increased roles in applied science and in the social sciences. Indirectly, the Vietnam war had an impact. By draining funds from domestic programs and by helping to create a negative feeling toward the government in general, the war contributed to an uneasy environment for the Foundation, particularly in its relations with its academic clientele. The last few years has seen a shifting context to which the Foundation has had to adapt. International economic competition in a high technology world places a premium on the ability of the United States to provide science and engineering research and education to meet the challenge. That context already has and will continue to shape the direction the agency will take.

Internally, policy and personnel shaped the direction the agency took and affected the place it presently has in the nest of federal agencies. Very early, the Foundation decided to use a flexible grant mechanism to support its programs rather than by purchase of research through contract. Likewise, the agency elected early to evaluate research proposals through various forms of peer review, thereby causing its programs to be science-driven rather than bureaucratically determined. Those policies have served the agency well and are a part of the Foundation's tradition. Equally important, highly skilled scientists and engineers formed the basic personnel element of the agency staff. Early in the Foundation's history, the policy of recruiting active researchers from the nation's universities to fill temporary assignments developed into a tradition that has provided the agency with a constant source of new blood and ideas. In addition, the practice has brought closer the association of the nation's colleges and universities with the Foundation.

Early experience with management of contractors who run the agency's large programs--such as Antarctic research, the astronomy and atmospheric research centers, and the ocean drilling program--has been beneficial to the Foundation. These enterprises allowed agency managers to be at the forefront of administering support for the new engineering research centers and the science and technology centers that are presently being developed.

Some issues have been debated since the early days of the Foundation and show no sign of being resolved to the satisfaction of everyone. The question of the fairness of peer review is raised periodically. The issue of geographic distribution of grants versus the objective of obtaining the "best science" has historically brought out advocates on both sides. The concern over applied versus basic science and engineering is a subject that also must constantly be discussed. The proper balance between individual science projects or "little science" and "big science" programs has been a subject of debate since the 1950s. While the arguments are often heated, the debate historically has been good for the agency because it forces policy makers to reassess those themes that go to the heart of the Foundation's mission.

Thus a strong case can be made for knowledge from the past to assist those who are presently creating history. The point is not to belabor the aphorism that "those who fail to study the past are condemned to repeat it," but rather to recognize that both continuity and change in history need to be understood to deal effectively with the present.

BIBLIOGRAPHIC NOTE

The history of the administration of the Foundation must be pieced together from many sources. This short note is meant to lead the reader to those places where one may begin to acquire an overview of the activities of the agency.

A. Hunter Dupree's, Science in the Federal Government: A History of Policies and Activities (Baltimore, 1986 reprint edition), is the classic, readable survey of the evolution of the relationship between science and government from the time of the Constitution to the eve of World War II. It provides a prologue to post-World War II activities. Significantly, the work was sponsored in 1956 by the American Academy of Arts and Sciences under a grant from the Foundation--one of the first efforts funded in the area of history of science.

The story of Vannevar Bush's wartime Office of Scientific Research and Development is ably recounted in Irvin Stewart, Organizing Scientific Research for War (New York, 1980 reprint edition). And Bush's famous 1945 report, Science--The Endless Frontier, is valuable reading to understand what the Foundation is all about. It set the philosophy for the agency. The Foundation reissued the report in 1960 with an introduction by Alan Waterman, and in 1980 with an introduction by Richard Atkinson.

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A breezy assessment of the Foundation is found in: Milton Lomask, A Minor Miracle: An Informal History of the National Science Foundation (Washington, 1976), that was written under contract for the agency. An authoritative account through 1957 is the official history by J. Merton England, A Patron for Pure Science (Washington, 1982). Dorothy Schaffter has written a straightforward factual work, The National Science Foundation (New York, 1969) in the Praeger Library series of U.S. Government Departments and Agencies. Michael D. Reagan, Science and the Federal Patron (New York, 1969), has a good analysis of the Foundation in Chapter Seven.

Often overlooked, but a mine of information, is the published collection of agency annual reports. They have been issued every year since fiscal year 1952. From 1964 through 1983 they have appeared in two volumes, the first narrative and descriptive, the second a listing of all grants and contracts made during the year. Since 1983, the agency has returned to a one-volume format without a listing of grants and contracts.

Three reports about the National Science Board are worthwhile reading. The National Science Board and the Formulation of National Science Policy (NSB-81-440) was written by Philip M. Smith in 1981 at the request of the Board. In 1983, the Congressional Research Service of the Library of Congress prepared The National Science Board: Science Policy and Management for the National Science Foundation, 1968-1980 for the Subcommittee on Science, Research and Technology of the Committee on Science and Technology of the House of Representatives. The volume is available as a committee print (U.S. Congress, House of Representatives, 98th Congress, 1st session, Serial E, January 1983). Margaret L. Windus in 1984 compiled a useful document: National Science Board Policy Activity Over the Past 10 Years (NSB-84-300).

In 1964, the National Academy of Sciences, through its Committee on Science and Public Policy, published Federal Support of Basic Research in Institutions of Higher Education. It provides a broad view of the development of federal support of basic research. Although over twenty years old, The Politics of Pure Science (New York, 1967), by Daniel S. Greenberg is still useful for the period up to 1967. W. Henry Lambright has let some dust settle on the issues of the 1960s in his recent book, Presidential Management of Science and Technology: The Johnson Presidency (Austin, 1985). Two other publications cover later Foundation activities. John T. Wilson, a psychologist and former Foundation administrator, wrote Academic Science,Higher Education, and the Federal Government, 1950-1983 (Chicago, 1983). Historian Jeffrey Stine wrote Science Policy Study Background Report No. 1, A History of Science Policy in the United States, 1940-1985. He prepared it for the Task Force on Science Policy of the House of

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